

ABSTRACT OF THE DISCLOSURE

An apparatus and method for cutting a material including conducting and non-conducting materials such as biological tissue, cellulose or plastic while the material is submerged in a conductive liquid medium. The apparatus has a cutting electrode with an elongate cutting portion having an aspect ratio (length to width) of 1 or more and a return electrode. The two electrodes are immersed in the conductive medium and a voltage is applied between them to heat the medium, thus producing a vapor cavity around the elongate cutting portion and ionizing a gas inside the vapor cavity to produce a plasma. The voltage applied between the electrodes is modulated in pulses having a modulation format selected to minimize the size of the vapor cavity, its rate of formation and heat diffusion into the material while the latter is cut with an edge of the elongate cutting portion. The modulation format includes pulses ranging in duration from 10 μ s to 10 ms, as well as minipulses and micropulses, as necessary. The apparatus and method of invention allow the user to perform efficient thermal ablation and electrosurgical procedures in particular at power levels as low as 10 mW with minimal thermal and cavitation damage.